



2008 Darcy Lecturer Michael Celia, Ph.D.

national
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National Ground Water Research and Educational Foundation presents

Henry Darcy Distinguished Lecture Series in Ground Water Science

Sponsored by a grant from the National Ground Water Association

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"The birth of ground water hydrology as a quantitative science can be traced to the year 1856. It was in that year that a French hydraulic engineer named Henry Darcy published his report on the water supply of the city of Dijon, France. In the report Darcy describes a laboratory experiment that he carried out to analyze the flow of water through sands. The results of this experiment can be generalized into the empirical law that now bears his name."

– R.A. Freeze and J.A. Cherry, *Groundwater*, 1979

In 1986, NGWA established the Henry Darcy Distinguished Lecture Series to foster academic interest and excellence in ground water science and technology. The lecture series, which has reached more than 58,000 ground water students, faculty members, and professionals since its inception, honors Henry Darcy for his scientific discoveries in 1856. Darcy's investigations established the physical basis upon which ground water hydrology has been studied ever since.

The series, which is sponsored by the National Ground Water Research and Educational Foundation, is supported by a grant from the NGWA. Annually, a panel of scientists and engineers from the NGWA membership invite an outstanding ground water professional to share his or her work with peers and students. The lecture is presented in response to invitations from universities throughout the world. No fee is charged to attend the lecture.

Future Lecturer

Michael Celia, Ph.D., has been chosen as the 2008 Darcy Distinguished Lecturer. Celia is chair of the Department of Civil and Environmental Engineering at Princeton

University. He received a B.S. in civil engineering from Lafayette College in 1978, and an M.S. (1979) and Ph.D. (1983) in civil engineering from Princeton University. In 1985, he joined the faculty of M.I.T., but returned to Princeton to join the civil engineering faculty in 1989.

Celia's areas of research include ground water hydrology, ecohydrology, numerical modeling, contaminant transport simulation, and multiphase flow physics. Ongoing projects include pore-scale network modeling to study interface dynamics, reactive transport, and scaling in porous media systems; computational studies of plant responses to variations in soil moisture in water-stressed ecosystems, with a focus on applications in sub-Saharan Africa; and studies associated with large-scale injection of CO₂ into deep brine formations as a possible mitigation strategy for the atmospheric carbon problem. The carbon work is part of a large, multidisciplinary effort at Princeton known as the Carbon Mitigation Initiative. Celia served for 10 years as editor of the journal *Advances in Water Resources*. He is a Fellow of the American Geophysical Union and recipient of the 2005 AGU Hydrologic Sciences Award.

Abstract/

"Geological Storage as a Carbon Mitigation Option"

Anthropogenic emissions of carbon dioxide have increased atmospheric concentration of CO₂ by about 35 percent during the past 200 years. The current concentration, at about 385 ppm, represents the highest CO₂ concentration in the last 500,000 years. Projected future emissions will lead to doubling of preindustrial CO₂ concentration within the next 50 years. If this

relentless increase of atmospheric CO₂ is to be reduced, or reversed, technological solutions must be implemented on a massive scale.

While many options are being considered, one attractive approach is carbon capture and storage, or CCS. The "geological storage" version of CCS involves capture of CO₂ before it is emitted into the atmosphere, and subsequent injection of the CO₂ into deep geological formations. Injection of CO₂ into deep formations leads to a multiphase flow problem that may involve important mass exchange between phases, nonisothermal effects, and complex geochemical reactions. In addition, because enormous quantities of CO₂ must be injected to have any significant impact on the atmospheric carbon problem, the spatial scale of the problem becomes very large.

Broad questions involving the fate of the injected CO₂, including possible leakage of CO₂ out of the formation, as well as the fate of displaced fluids like resident brines, lead to very challenging modeling and analysis problems. Because important leakage pathways can be very localized, and their properties can be highly uncertain, an overall analysis of the system requires resolution of multiple length scales in the context of a probabilistic approach. These requirements render standard numerical simulators ineffective due to excessive computational demands. A series of simplifying assumptions may be proposed to provide more efficient numerical calculations, even to the point of allowing for analytical or semianalytical solutions. Such simplifications, while restrictive in their assumptions, allow for large-scale analysis of leakage in a probabilistic framework while capturing much of the essential physics of the problem. Example calculations illustrate the utility of these methods, and show the current state of leakage estimation. They also lead to a proposal for specific field experiments that can reduce the uncertainty associated with potential leakage pathways.

Eligible Hosts/

Academic institutions are encouraged to host the Henry Darcy Lecture by completing the online request form.

Companies and organizations may also request to have the Henry Darcy Lecture Series given at their facilities via the online form.



Henry Darcy Distinguished Lecture Series in Ground Water Science

Deadline for Applications is October 15, 2007.

Please visit our Web site, www.ngwa.org, to access and complete the Darcy Lecture Series request form. All requests to host the Darcy Lecture Series must be submitted to NGWA headquarters by way of this online submission form. No other methods of requests will be accepted.

All applications must be received by October 15, 2007. Lecture confirmations will be mailed in early December to those colleges/organizations/companies that have been selected to host the 2008 Darcy Lecturer. Confirmations will only be made by the National Ground Water Research and Educational Foundation.



For more information, contact Barbette Howell at 800 551.7379 (614 898.7791 outside the United States); e-mail to bhowell@ngwa.org.